

DATA INTERNATIONAL III

Electrical Appliances

In September 1965, a letter was received by DATA International of Palo Alto, California, from a missionary who was preparing to go to Uruguay, South American, asking advice regarding electrical appliances he could purchase and use on the 60 cycle voltage supply in the States and could also use on the 50 cycle voltage supply in Uruguay.

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(c) 1966 by the Board of Trustees Leland Stanford Junior University.

This case was prepared by Professor James W. Hill, California State College at Long Beach, during the Summer Institute on Case Methods supported by the National Science Foundation at the Stanford School of Engineering, 1966.

## Background

Development and Technical Assistance (DATA) International was organized in 1959 as a volunteer organization operating as a clearinghouse for finding technical information for Americans living and working in the remote corners of the world who find themselves with problems they cannot solve without help. DATA began by specializing largely in helping American missionaries abroad who found themselves faced with technical problems outside their experience.

With the advent of the Peace Corps and the increasing numbers of voluntary-agency representatives abroad, DATA is branching out to offer its services to all Americans working in or near the village level worldwide. DATA leaves the big problems of foreign aid to others and tackles the "bite size" problem that is big to some individual struggling overseas.

Since its inception DATA has received more than 5,000 letters from people all over the world, each asking help on one or more problems. DATA has enlisted more than 1500 specialists -- engineers, scientists, doctors, etc. -- who are willing to give freely of their time and effort toward the solving of these problems.

When a request for help is received, DATA customarily sends the problem to at least three of its consultants, in order to take advantage of independent opinions. They may also send inquiries to manufacturers asking for assistance on the problem. Replies from these sources are then sent to the person who requested help.

Thus, DATA provides the connecting link between the person with a problem and the person with an answer.

Such a letter was received from C. W. Van Dolsen of Warrensburg, Missouri, who was on the point of leaving for Uruguay as a missionary. His problem is stated in his letter, a copy of which is shown in Exhibit 1.

Following the customary procedure, DATA forwarded copies of the letter with a request for assistance to consultants, whose replies are shown as Exhibits 2 through 5.



Cozetta, C. W. and Warren

MISSIONARIES TO URUGUAY,  
SOUTH AMERICA

4399

C. W. Van Dolsen  
703 South College  
Warrensburg, Mo.  
September 30, 1965

Dear Sir:

We have been referred to you by Missionary Equipment Service of Chicago. In going out to Uruguay I have some questions concerning the electric current. Uruguay requires appliances to be used before they enter the country. This means that we must use them here and there. Realizing that their current is 220 volt 50 cycle, I am wondering how to do this.

The refrigerator seems to have no problems. I can buy one with a motor for 110 volts 50/60 cycles. I can use it here and with a transformer to change their 220 to 110, I can use it there.

Is there an electric range on the market that has the 50/60 arrangement for the clock, timer, etc? Our electric ranges are 220 volt. Will this work with their current. It has been brought to my attention that our 220 volt require three wires and perhaps theirs only requires two. Is this correct? And, would it make a difference other than perhaps a different type plug? Are these change over plugs available?

I can buy an automatic washer either 220 volt 50 cycle or 110 volt 60 cycle. Could I just buy the 110-60 to use here and change the motor for the 220-50 for use there? How much change would there be? By changing the motor and perhaps a pulley and belt, would this make the complete change so the the washing cycles etc. would work properly?

I would also need to know the same information for an electric dryer. Or, could I buy a 220 volt 60 cycle dryer here and use it there expecting the time of the drying cycles to be off somewhat?

Thank you for any information you can give me.

Sincerely,

*C. W. Van Dolsen*

C. W. Van Dolsen





**international**

437 CALIFORNIA AVENUE  
PALO ALTO, CALIFORNIA

OCT 20 1965

## Answer Form

PROBLEM NO. 4399

YOUR ANSWER:

please type or print  
ON THIS SIDE ONLY

To be of maximum value a reply  
should be received by 27 Oct

65

You should have no trouble operating a 110 volt 60 cycle refrigerator in Uruguay providing, as you suggest, you use a transformer to step voltage down from 220 to 110. The 50 cycle current would only cause the unit to run at 5/6 the speed it should run on 60 cycles, but this should cause no difficulty in a refrigerator.

The U. S. standard for electric ranges is 220/110 volts, 3 wire. This means that between two "line" wires the voltage is 220 volts and between either "line" wire and "neutral" the voltage is 110. Standard U. S. ranges are designed to utilize 110 volts on the low-medium heat positions. I am sure Uruguay uses only 2 wire 220 volts which is not suitable for a standard U. S. made range. It would be possible to get a transformer for this application, but it would be very costly as ranges consume a considerable amount of power. The timer and clocks would run at 5/6 the normal speed anyway since the frequency would be 50 cycles.

The same comments on electric ranges would apply to the electric dryer.

It would be feasible to use a transformer to step voltage down from 220 to 110 volts for a washer as they don't consume much more power than a refrigerator. Of course the motor and timer would also run at 5/6 the speed as on 60 cycles. This would only mean, for example, with the timer set at 20 minutes, it would ~~would~~ actually run for about 24 minutes. Of course the machine will run at slightly slower speed, but this should not be harmful.

Some major manufacturers of appliances in this country make appliances that will operate at other voltages, such as 220 volts, 50 cycles. I would suggest you write to Westinghouse International Company, 200 Park Avenue, New York, or General Electric International Company in New York City, or some other such as Frigidaire. I am sure one of these companies can arrange to sell you appliances with proper voltage and frequency. However, it is questionable if you would be able to use them here before you left. I would suggest following the manufacturers' recommendation on this point.

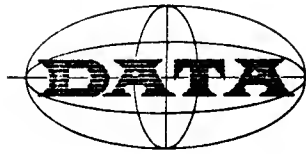
DATA International, on behalf of the Staff, Consultants, Sponsors and Assistance Agencies co-operating, is pleased to render this problem-solving service, but must of necessity disclaim all liability for its use or application.

DATE 10/15/65

FROM

James R Monroe

Exhibit 2

**international**437 CALIFORNIA AVENUE  
PALO ALTO, CALIFORNIA

OCT 18 1965

**Answer Form**PROBLEM NO. 4399

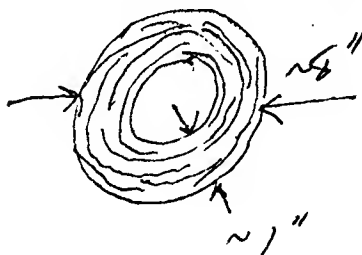
YOUR ANSWER:

please type or print  
ON THIS SIDE ONLY

To be of maximum value a reply  
should be received by Oct 27, 65

This problem concerns use of 60 cycle A. C. electrical equipment with 50 cycles or 50 cycle equipment with 60. The answers are complicated because alternating current impedance (a kind of "resistance" which holds back current and prevents too much flowing through the equipment, which otherwise might overheat and burn out) is proportional to the number of cycles per second. In 1934 I took my General Electric Refrigerator to Sumatra where they also had 220 volts but 50 cycles. I bought an auto transformer here to reduce the voltage from 220 to 110, but was advised by the shop foreman there that a further reduction was necessary. The amount of reduction may be estimated by considering that most of the impedance of an electric motor is attributable to the inductance of the windings (relatively little resistance loss in the wiring). If the motor is rated to stand 120 volts at 60 cycles, then five sixths of that voltage (50 divided by 60) at 50 cycles will send the same amount of heating current through its windings. That means if your transformer would deliver 120 volts, a further reduction of one sixth that amount or 20 volts is necessary. A resistance capable of dropping voltage by 20 would produce heat and cause excessive charges for unused or wasted electricity. A choke coil, on the other hand, dissipates the voltage but feeds the energy back into the line so there would be only minor additional charge for unused kilowatt hours of electricity.

The choke coil which I made consisted of a toroid (dough-nut) of lengths of soft iron wire. The larger diameter of the toroid was about 8 inches, the smaller about 1 inch. Around the toroid was



wound regular insulated electrical wire, about number 12 or 14. Caution: be sure you have adequate electrical insulation to guard against shock hazard, which is especially vicious with 220 volts and an auto-transformer! The actual amount of wire used had to be arrived at by cut and try until the voltage drop across the coil when connected in series with the terminals to the icebox was enough to reduce that

across the icebox to the specified amount.

A different coil might have to be wound for each different 60 cycle motor you might want to use with 50 cycles.

Continued on following page.

DATA International, on behalf of the Staff, Consultants, Sponsors and Assistance Agencies co-operating, is pleased to render this problem-solving service, but must of necessity disclaim all liability for its use or application.

DATE Oct 15, 1965

FROM

  
Donald S Villars

4399

Now, to discuss your specific questions. Unless your refrigerator motor for 50/60 cycles has different input connections for the different number of cycles, I would be skeptical that it might overheat if you let it run on the slower number of cycles. (Also, the motor is almost sure to run only five sixths as fast. In our case, it was running 100% of the time in the heat of the tropics-- not cutting on and off like it normally does here at 60 cycles.)

I know of no electric range that has a 50/60 cycle clock or timer. These are usually run by synchronous motors and if the number of cycles is 50, they will only run five sixths as fast as at 60. (I doubt that you will find any spring wound clocks or timers on an electric range.) The clocks probably also run on 110 volts. The heating part of the range is completely independent of the number of cycles, so no choke coil would be required. You will probably not find three wires for 220 volts in Uruguay. (If you do you better get local instruction!) If you can identify which is the middle wire of your 3, you can try leaving it unconnected, but beware of your clock and timer, as they might get burned out if they work on 110 volts and depend upon the two 110 v. sides being accurately balanced so as to give exactly 110 v. to the clock at all settings of your burner switches.

Changing a motor there to another which runs at 220 v., 50 cycles sounds expensive. Also you will not be able to claim it as "used". Since you are buying new equipment and are not confronted with the problem of having to make do with what you already have, I would feel inclined to prefer to buy the 220 volt 50 cycle equipment here plus a transformer from 110 to 220 (an auto-transformer used to be cheaper) for 60 cycles here. The equipment might not run as well or as efficiently here but I don't believe you would be likely to get into as much trouble as you could by doing it in reverse fashion; i. e., try to make do on 50 cycles with 60 cycle equipment and have to wind several choke coils.

I wish you luck in your tour of duty in Uruguay. Mrs. Villars and I spent a day in Montevideo on a tour of South America last February. I was very glad to leave because it was the only country we encountered with so many insulting anti- U. S. signs.

VILLARS - C-6307  
Page 2  
2  
+1

**international**437 CALIFORNIA AVENUE  
PALO ALTO, CALIFORNIA**Answer Form**PROBLEM NO. 4399

YOUR ANSWER:

please type or print  
ON THIS SIDE ONLYTo be of maximum value a reply  
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In my limited time on this business trip to the General Electric facilities at Valley Forge, Pa. I have gotten this information from my local inquiries & from a Field Engineer for International General Electric. This is all the assistance I can render immediately but perhaps it will help.

First the refrigerator. G.E. units sold in the United States are rated for either 115 volts at 60 cycles or 100 volts at 50 cycles. An electric motor runs hotter on 50 cycles and in a hermetically sealed refrigeration unit the voltage must be lowered to reduce heat dissipation within the unit. Since all refrigerators produced in the U.S. have similar units I am pretty sure that any refrigerator you take should be operated at 100 volts (plus or minus 10 percent, or 90 to 110 volts). Make sure that the transformer you buy has taps on it so you can select the optimum voltage output and make sure the transformer is big enough. For 1/4 horsepower motor use a transformer rated at 550 volt-amperes or more and for a 1/3 horsepower motor use at least a 750 VA transformer.

Next the electric range. There is no way to convert a clock or timer from 60 cycles to 50 cycles. Ranges in the U.S. are wired for 3 wire 220 volts. One wire is neutral, one wire is plus 115 volts, and one wire is minus 115 volts. Both 115 volts and 230 volts is available within the stove. The clock, timer, lights and appliance outlets use this 115 volts. On stoves with 5 level heat control, 115 volts is used for 2 levels of heat. An electric stove with no clock, timer or fluorescent lights and having either 3 level heat control or infinite heat control could be easily converted for 2 wire operation in Uruguay. Any incandescent bulbs (like the oven light) would have to be replaced with 220 volt bulbs. I am sure a different connector is required and is not available in the U.S. Uruguay has 2 wires, one neutral, and one 220 volts. On the stove,

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DATE 11/1/65

FROM

Robert H. Johnson  
Robert H. Johnson

BY RH Johnson DATE 11/1/65 SUBJECT Problem no. 4399 SHEET NO. 2 OF 3  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ JOB NO. 4399

connect the neutral terminal and the negative terminal together and tie them to the neutral wire and to a convenient water pipe or metal stake driven into the ground. Tie the 220 volt wire to the plus terminal on the stove. There is one warning. An electric stove can draw at least 9000 watts (or 9 kilowatts, written 9 kw). Be sure and check with the local authorities in Uruguay to see if 9 kw is allowed on a 2 wire single phase line. They probably will not allow it or will require the installation of additional service.

Now the washer. On export models of GE washers, the 50 cycle models use a larger clutch drum and heavier shoes. The relay must match the motor current so the 50 cycle models have a different relay. These 3 parts must be changed to convert a 50 cycle model to a 60 cycle model. The heavier drum and shoes overload the motor at 60 cycles. To convert to 50 cycles from 60 cycles the motor must be changed also. The 60 cycle motor is not built to stand the extra heat dissipation. It was estimated that these three parts would cost approximately \$15- and would take 2 hours to install. I did not get a price on motors. You probably can't buy a 50 cycle GE washer or parts. GE does not change the timer or gear ratios on their washers. They use the same for both 50 cycles and 60 cycles. But they do wind the timer motors with larger wire to handle the increased current on 50 cycles. If you can buy a washer for 220 volt, 50 cycle operation that does not require these changes in order to work on 60 cycles, you could just connect to the 230 volts, 60 cycles available here in the US and use it, as is. There is another factor to be considered also and that is water pressure. If the water pressure falls below 10 pounds per square inch, the valve on an automatic washer will not open. GE sells a semi-automatic washer that must be filled by hand. When you have dumped enough water into it, the wash (or the rinse) cycle will start. I do not believe any of the GE export models are available in the US.

And last, the drier. If you can buy a drier that is rated for both 50 cycles and 60 cycles, the motor would not have to be changed. However the drier, like the range, is supplied with 115 volts also and the timer motor is 115 volts. You would have



Exhibit 4 (Con't.)

CHKD. BY R.H. Johnson DATE 11/1/65 SUBJECT Problem no. 4399 SHEET NO. 3 OF 3  
DATE 11/1/65 JOB NO. H-1111

to install a small transformer to supply 110 or 115 volts for the timer motor.

These answers are sketchy and quick, I already wish I had time to go back, rewrite, clarify and add more information. But possibly just this much will help you to ask more specific questions so that we can be of further help.

Yours in the Lord's service  
Robert H. Johnson

**GENERAL  ELECTRIC**

**IGE EXPORT DIVISION**  
GENERAL ELECTRIC COMPANY  
159 MADISON AVE., NEW YORK, N.Y. 10016  
-U.S.A.-

AREA CODE 212  
TELEPHONE: PLAZA 1-1311  
CABLE ADDRESS: "INGECO, NEW YORK"

January 28, 1966  
JWR - 2084

Mr. Douglas K. Hayward  
DATA INTERNATIONAL ASSISTANCE CORPS.  
437 California Avenue  
Palo Alto, California 94306

Dear Sir:

With reference to your problem number 4399, please be advised as follows and within the limits of this problem as they apply to General Electric appliances only. Due to design differences between manufacturers the information hereinafter provided may not be taken as being applicable to major appliances manufactured by other companies.

Our refrigerators and freezers, normally used on 115 volts, 60 cycles, can all be used on 50 cycles if the voltage is transformer reduced to 100 volts, 50 cycles. In our case we do not like to see 110 volts still less 115 volts applied to the motor when the line frequency is 50 cycles.

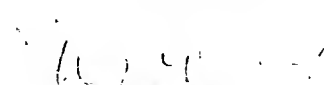
There is no such thing as an electric 50/60 cycle clock. It is either one frequency or the other and mechanical parts have to be changed (rotor) to compensate for the difference in frequency. If the voltage has to be changed either a small transformer has to be used or the field coil has to be changed.

Most American electric ranges are designed for 236/118 volts, 60 cycles, 3-wire, single phase service. This type of service normally provides 5 heats on the surface units. A single phase 220 volt, 2-wire service only provides 3 heats and among other components all the switches have to be changed and these ranges are specially manufactured. Changing the plug does little or nothing.

The conversion of a standard domestic washing machine or dryer for use on 220 volts, 50 cycles involves changing many components. Compared with the first cost of a machine manufactured for this type of electrical service, the conversion charge is usually uneconomical. It should be realized that the washer motors work in conjunction with a relay that is frequency sensitive and this also has to be changed.

In order to handle inquiries of this type we have set up five Authorized Exporters in New York, Washington, D.C., Miami, San Francisco and Los Angeles. These outlets carry the special export material and are equipped to take care of the needs of U.S. continentals proceeding overseas. We attach a sheet showing the addresses of these outlets.

Very truly yours,

  
J. W. Reynard  
PRODUCT SERVICE

AUTHORIZED EXPORTERS

Thor Export Sales Co.  
130 Madison Avenue  
New York, N.Y. 10016

Pacific-King  
1222 West 6th Street  
Los Angeles, California

Allied Export Distributors  
9001 "G" Street  
Oakland 3, California

General Electronics, Inc.  
4513 Wisconsin Avenue, N.W.  
Washington 16, D. C.

Hopkins - Smith  
P. O. Box 8368  
Fort Lauderdale, Florida